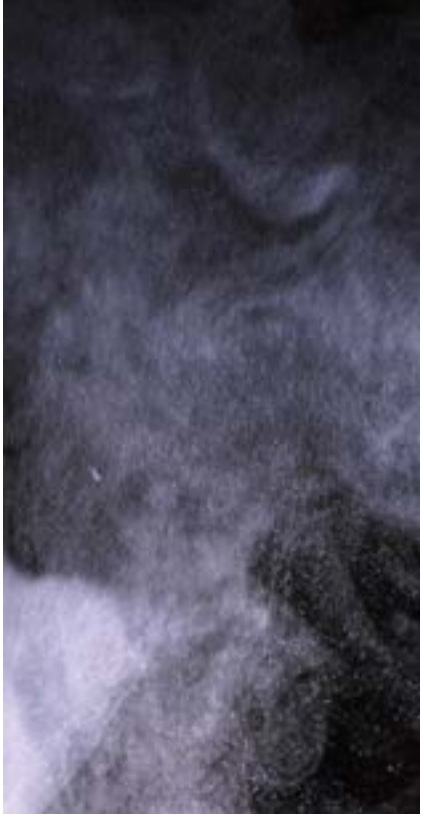
NETZSCH

Proven Excellence.

NETZSCH Steam Jet Mill *s-Jet*®

Ultra-fine dry-grinding down to the submicron range

Business Unit
GRINDING & DISPERSING


NETZSCH *s-Jet*®

Dry-grinding down to the submicron range

Water vapor is the oldest form of thermal energy known to man, commonly understood as visible clouds of steam (saturated steam). Naturally this kind of saturated steam is not suitable for use inside a dry-grinding mill. However, saturated steam is not the only form of appearance of water vapor!

The *s-Jet*® process which was developed and patented by NETZSCH uses super-heated steam as a grinding gas – this is absolutely dry!

The *s-Jet*® Steam Jet Mill is a systematic further development of those air jet mills with integrated air classifier already established on the market. If steam is used as a grinding medium instead of air, then the jet energy available is significantly higher. The *s-Jet*® machine is the key to obtaining higher capacities and new ranges of fineness (submicron) with dry grinding.

S-JET®

STEAM, SUPERFINE & SUPEREFFICIENT

NETZSCH Steam Jet Mill *S-JET®* 500

The s-JET® process

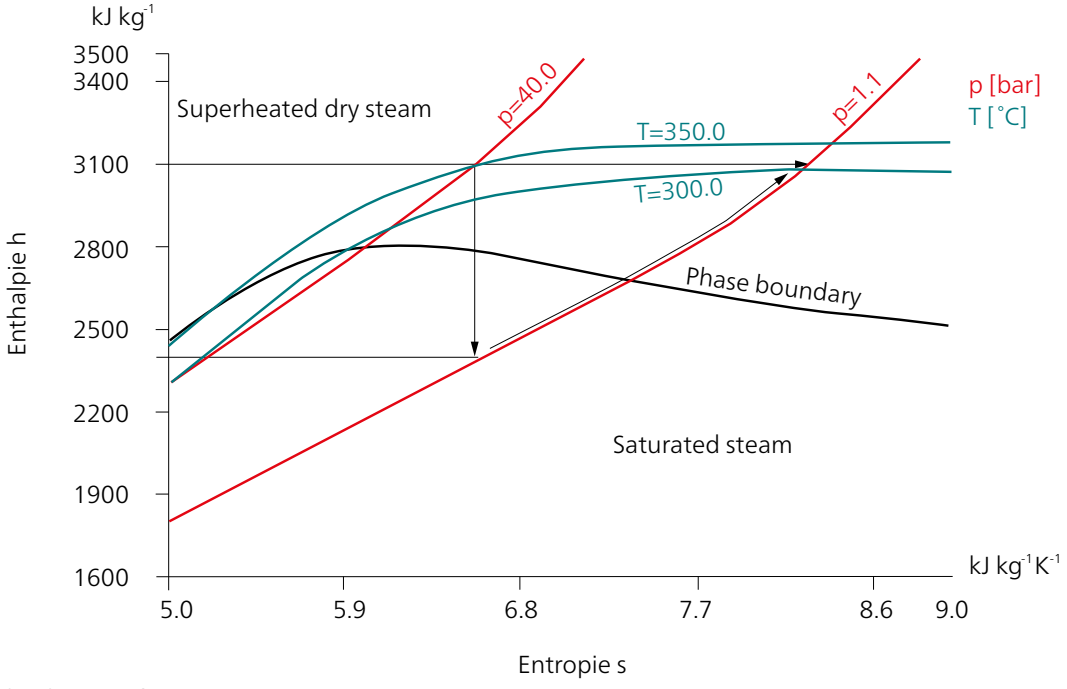
Dry grinding with superheated steam

The use of superheated steam as a grinding medium in jet mills is well-known, but up until now it was only used with a simple spiral jet mill without an integrated air classifier. Now the *s-JET®* system by NETZSCH makes use of superheated steam as a grinding medium in fluidized bed jet mills with integrated dynamic classifier so that a reliable limiting of the maximum particle size is possible.

Due to the great variety of application areas in which it can be used, the combination of the mediums water/steam is one of the most thoroughly empirically researched systems. The h-s diagram shows the thermodynamic data for steam.

For example, steam jet mills can be operated when the inlet state of the steam is 40 bar and 350°C (inlet enthalpy: around 3100 kJ/kg). The expansion in the nozzles is so rapid that this process can be described as isentropic. After the expansion in the mill (p = 1.1 bar, T = 300°C) the enthalpy is then only 2400 kJ/kg. At stagnation point the steam jet is decelerated in front of the particles (by momentum exchange) down to their speed (in axis of jet = 0). At this point the steam content is around 88 %, the temperature 102°C.

However, as external work is not dissipated in a jet mill, in the end the enthalpy again reaches its original value. The result of this is a temperature of around 300°C. The previously mentioned deceleration is repeated at the stagnation point of each particle entering the jet. As a result, we can conclude that the product being ground does not come into contact with saturated steam.



h-s diagram of water vapor

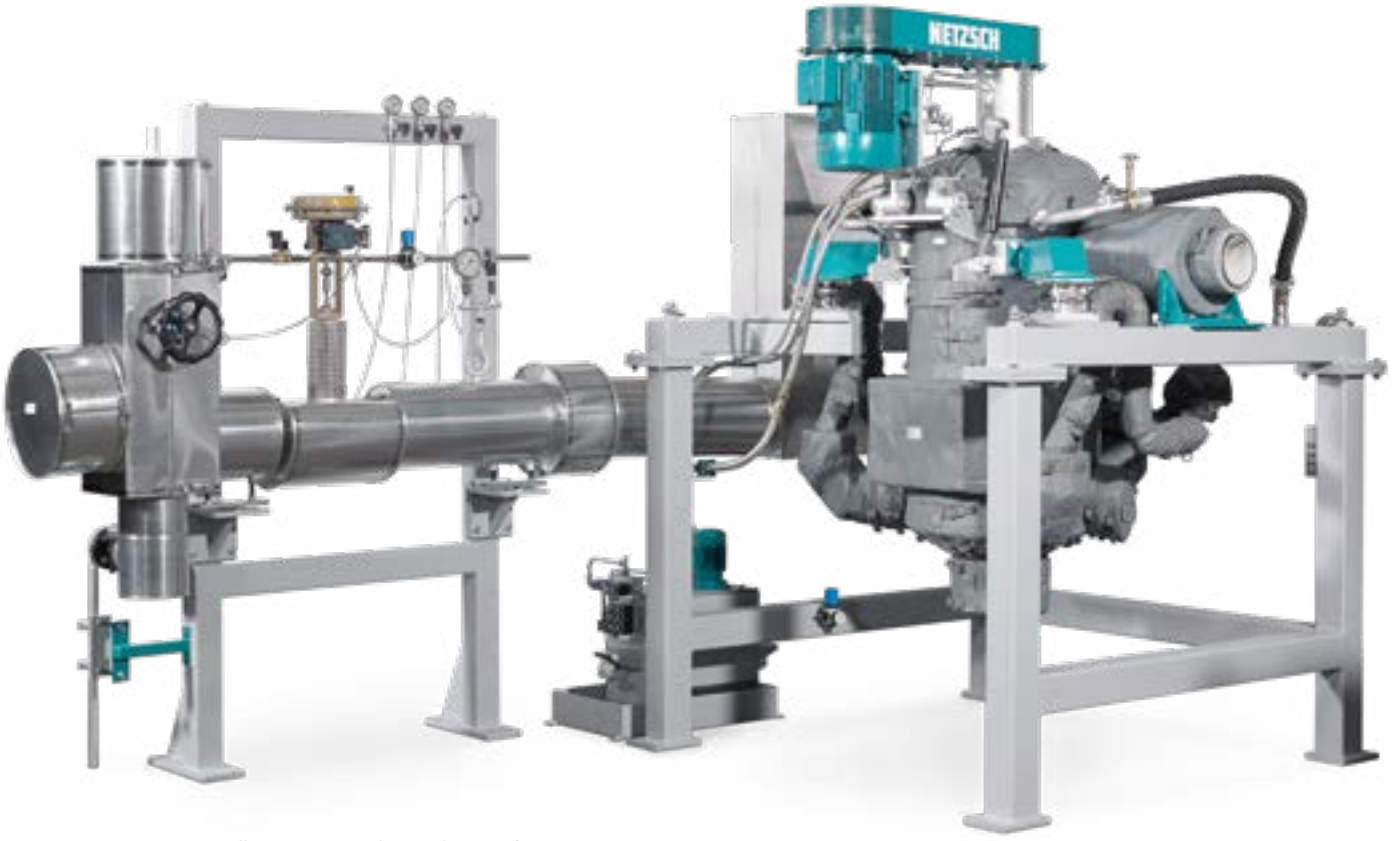
FOCUS ON

YOUR ADVANTAGES

Higher Jet Speeds for Finenesses in the Submicron Range

In the *s-Jet*® mill jet speeds of up to 1200 m/s, around twice as high as those achieved with conventional air jet mills, can be obtained by using steam as a grinding medium. As a result there is a fourfold increase of the discrete energy input and the kinetic impact energy within the fluidized bed!

With the *s-Jet*® process a decisive step has been taken to achieve finenesses in the submicron range with dry-grinding.



NETZSCH Steam Jet Mill *s-Jet*® 500 with grinding air fittings

FOCUS ON

YOUR ADVANTAGES

Reliable classifying of extremely small particles for products with steep particle size distributions

As steam has a significantly higher sound velocity than air, the possible peripheral flow speed within a classifier wheel increases and with this the acceleration forces which affect the product being classified.

The reduced dynamic viscosity of the steam also contributes to reducing the resisting force on the particles.

These two decisive factors together with the *ConVor®* classifier wheel make it possible to classify particles in the submicron range by dry-grinding.

In comparison to conventional air jet mills, significantly finer products with steeper particle size distributions can be achieved with the *s-Jet®* steam jet mill.

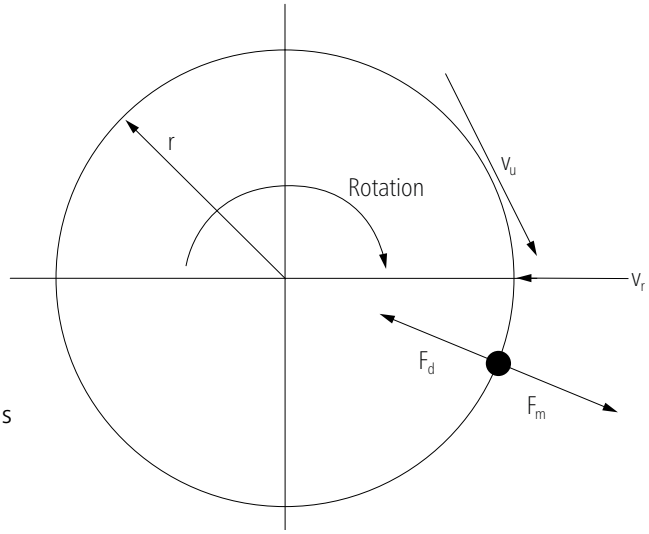
Example of product	Feed fineness d_{99} [µm]	Final fineness d_{50} [µm]	Final fineness d_{99} [µm]	Grinding medium
Graphite	12.0	2.46	6.27	Air
Graphite	12.0	0.82	2.24	Steam

ConVor® classifier wheel

Stokes Equation

$$d_T = \sqrt{\frac{18 \cdot \eta_c \cdot v_r \cdot r}{\rho_s \cdot v_u^2}}$$

d_T	Cut Size
η_c	Gas Viscosity
v_r	Radial Velocity
r	Classification Radius
ρ_s	Material Density
v_u	Peripheral Velocity
18	Constant



F_d	Drag Force
F_m	Mass Force

Example of product	Feed fineness d_{99} [µm]	Final fineness d_{99} [µm]	Grinding medium	Throughput capacity [kg/h]
Silica	166	10.2	Air	100
Silica	166	9.25	Steam	270

Increase of throughput for coarser grinding finenesses

The use of steam as a grinding medium not only makes it possible to produce product finenesses in the submicron range, but also has interesting economic aspects when coarser product finenesses are required. Depending on the properties of the steam the total energy input is increased by a factor of approx. 2.6. This exceptionally high energy yield can be used to significantly increase the throughput capacity.

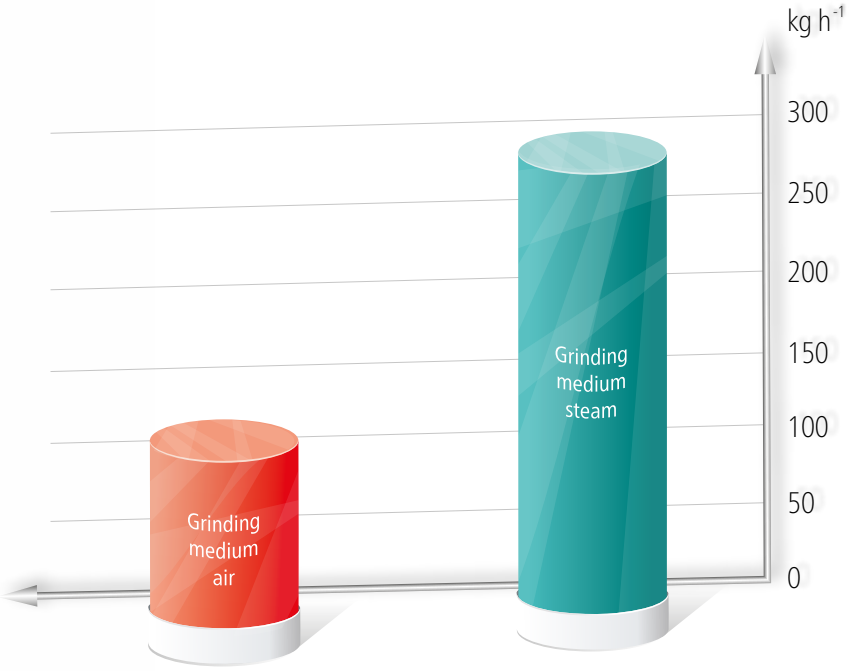
If finenesses, which can already be obtained using conventional air jet mills, are required with a comparable size *s-Jet*® machine , the throughput capacity can be **doubled or even tripled**.

The results of this are corresponding energy savings and lower costs.

Focus on your advantages

- Grinding finenesses < 130 nm (d_{50})
- Steep particle size distribution
- Significant increase of throughput capacity
- Considerably higher economic efficiency
- Optimal product performance
- Low contamination grinding for highest product purity
- Processing of sticky products
- Development of new products and applications

NETZSCH Steam Jet Mill *s-Jet*®150



NEW POSSIBILITIES

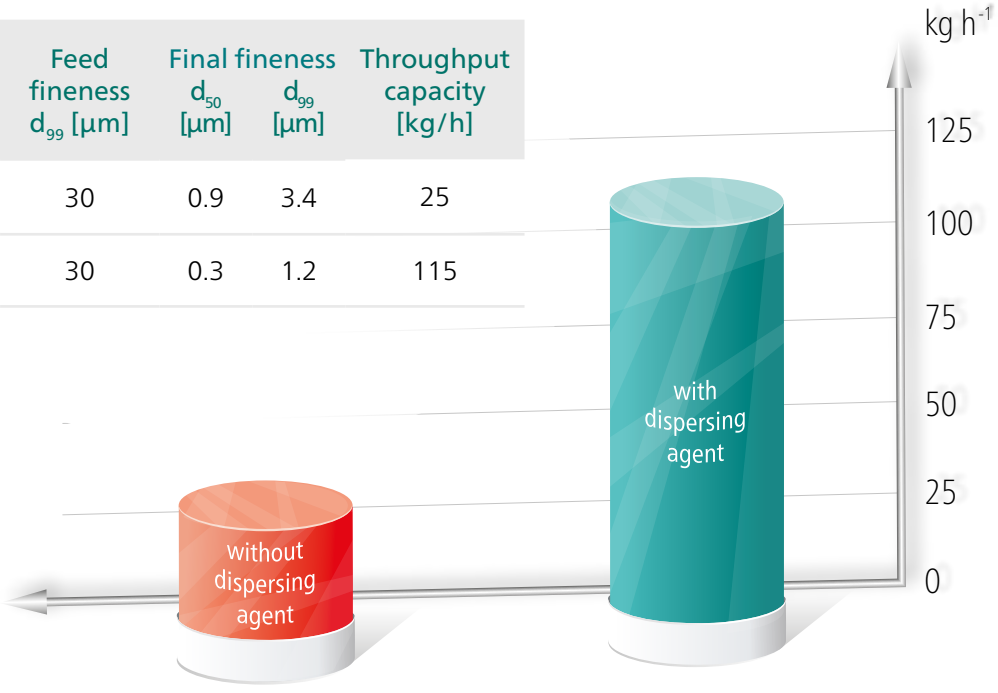
AND FIELDS OF APPLICATION

Optimization of the grinding process with dispersing agents

During all grinding processes, whether wet or dry, small particles show a tendency to reagglomerate. The finer the product particles, the more often this reaglommeration is likely to occur. This formation of agglomerates during dry-grinding results in a reduction of throughput capacity and process efficiency. The classifier wheel integrated in the mill recognizes the agglomerate as large particles rather than the individual fine particles. These agglomerates are returned to the grinding process. Therefore, in a closed grinding-/classifying process like a fluidized bed jet mill, these agglomerates remain longer in the mill in order for them to ostensibly be more-finely ground.

Therefore, the immediate stabilization of the particles produced by grinding is of great importance and is achieved by the addition of a suitable dispersing agent. In general, these are used in the order of 0.1 to 1 % to reduce the surface charge and in this way to prevent the reagglomeration of the particles and to enable the classifier to separate more finely. Depending on the product being ground and the additive used, not only is the output rate increased fivefold, but also the flow properties of the product are improved, the particle surface is enlarged and the formation of product deposits in the mill is reduced.

Example of product	Dispersing agent	Feed fineness d_{99} [µm]	Final fineness d_{50} [µm]	Final fineness d_{99} [µm]	Throughput capacity [kg/h]
Oxide ceramic materials	without	30	0.9	3.4	25
Oxide ceramic materials	with	30	0.3	1.2	115

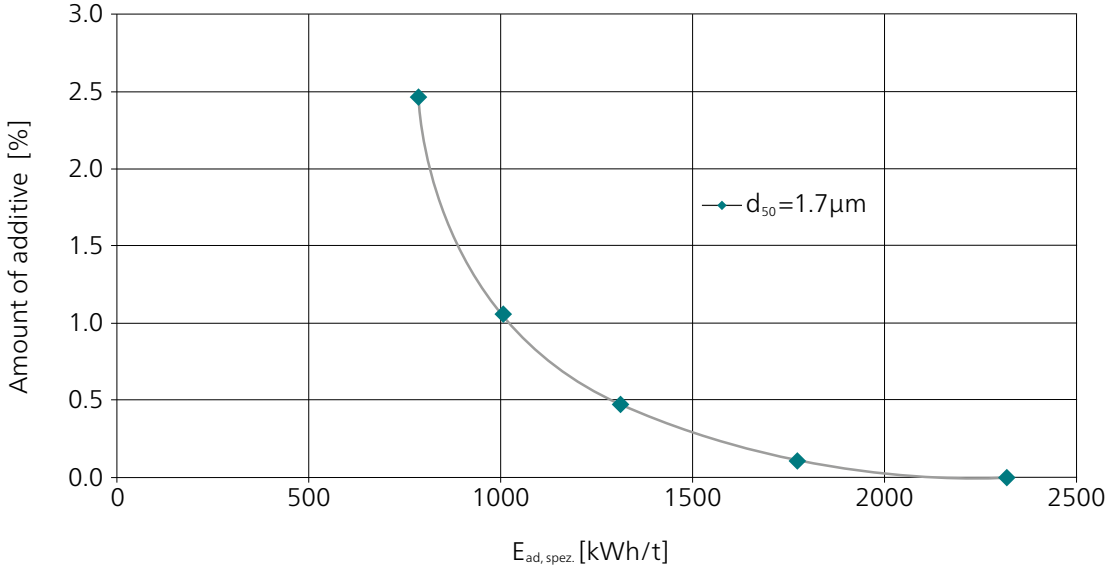


In the *s-Jet*® system the dispersing agent can be added in solid or in liquid form. The solid form is added directly to the feed product via a dosing unit, whereas the liquid additive is fed directly into the jet mill via a dosing pump. Any volatile additives disappear in the process around the input area of the machine and do not affect the quality of the product. This fact has been confirmed by means of check studies carried out by customers.

The optimum amount of additive required is based on the product to be ground and the most suitable type of dispersing agent. To determine this, corresponding optimization tests can be carried out in the NETZSCH test center.

Focus on your advantages

- Increase of throughput capacity (up to fivefold)
- Improvement of flow properties
- Enlargement of surface
- Reduction of formation of product deposits
- Lower specific energy requirement



Specific energy requirement depending on amount of additive

NEW POSSIBILITIES

AND FIELDS OF APPLICATION

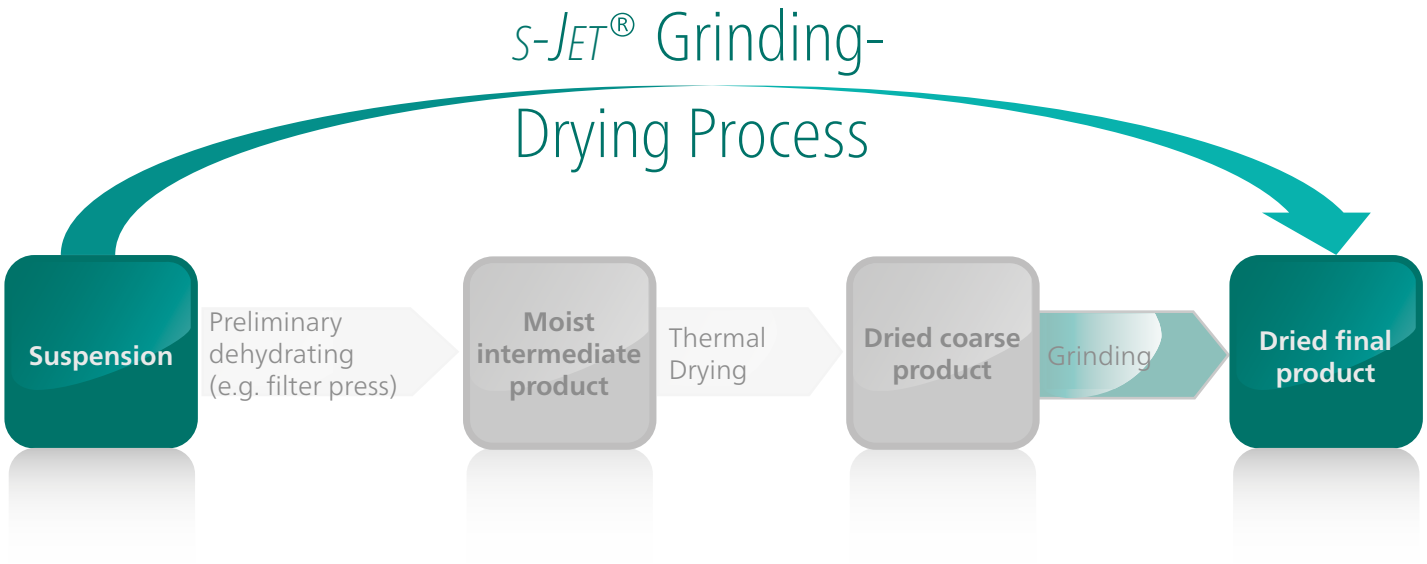
Grinding-drying with the Steam Jet Mill *s-Jet®*

An interesting variant of the *s-Jet®* process is the NETZSCH grinding-drying process (patent pending). In this process the product is not only ground but dried at the same time. The high temperature of the super-heated steam (> 300°C) and the increase of the particle surface in the grinding process cause the evaporation of the moisture contained in the particles.

For products which have a moisture content of up to 60 % a residual moisture content of down to approx. 0.5 % can be achieved. The potential savings due to reduced plant technology requirements and energy costs are huge!

You save money because

- Grinding and drying are in one single process step
- Certain equipment requirements are eliminated
- Energy costs usually incurred for dehydrating and thermal drying are saved



An interface of the steam jet mill *s-Jet*® to NETZSCH-*Connect* enables the collection and saving of various process data. This information is recorded continuously, preprocessed and encoded via a VPN-network and then transferred to a central server installed with an external provider as an XML-file. The data can be viewed, analyzed and exported by personnel who have the corresponding access authorization.

Users of NETZSCH-*Connect* can view the plant status of each machine and receive information about any relevant changes in the production process. This data can be used to draw conclusions regarding the production quality. The evaluation of process data over a longer period provides details of production- and downtimes as well as their possible causes and can be used to improve the planning of maintenance- and repair work on the plant.

Furthermore, certain authorized NETZSCH service employees can have access to the control system via remote maintenance.

NETZSCH-*Connect*

MONITORING AND REMOTE SERVICE SYSTEM

Focus on your advantages

- Simple handling
- Worldwide access
- Safe, thanks to VPN connection
- Individual configuration
- Reports on-call
- Maintenance assistance possible
- Cost effiency
- Optimization of your production

STEAM

AS A GRINDING MEDIUM

Production of superheated steam in the *s-JET*® Process

In many companies in the chemical industry superheated steam or at least saturated steam is readily available as a "by-product". This means grinding energy for the operation of the *s-JET*® mill available "for free".

If steam is not available, NETZSCH can supply the complete steam generating equipment if requested. NETZSCH has worked together with manufacturers of steam generators and superheaters to develop their own design which can be delivered as a Skid System for small to medium amounts of steam.

The five basic components of the steam generator are:

- A water treatment unit,
- A feed water tank for degasification,
- A pressure boosting,
- A steam boiler
- and a superheater.

In order to ensure the constant operation of the plant and prevent problems with corrosion and calcination, the first step must be the treatment of the raw water used.

After this the treated water in the feed water tank is degasified and the pH-value adjusted. The necessary pressure is generated via the feed water pump.

Thermal energy is applied to the water in the boiler until it becomes saturated steam. An integrated superheater converts this to superheated, dry steam. During the pressure increase hardly any energy/medium is lost and the steam eventually leaves the boiler in the direction of the mill at the required pressure and corresponding temperature.

Superheated steam

The temperature of superheated steam is higher than boiling point. This type of steam is „dry" and contains no water droplets.

Water Treatment

Feed Water Tank with Pressure Boosting

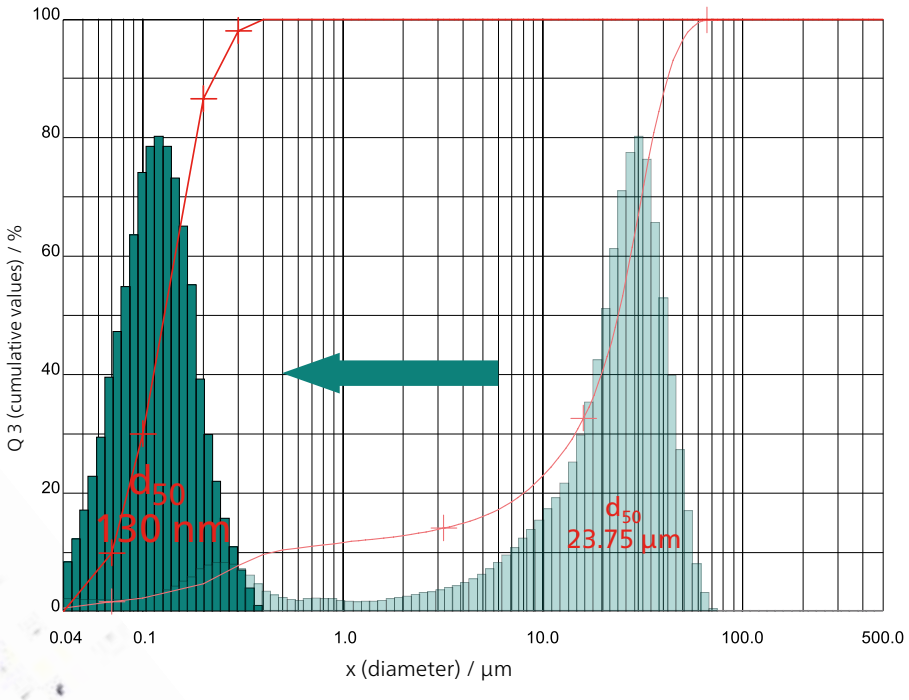
Steam Boiler with Superheater

WIDE RANGE

OF APPLICATION AREAS

The *s-Jet*® grinding system opens new doors for the production of particle sizes in the submicron range with an exact particle size distribution by dry-grinding, provided that the product to be ground is temperature-resistant.

Many different products such as minerals, ceramics, pigments and raw materials for batteries are successfully processed on a steam jet mill *s-Jet*®. Further products are being added to this list constantly and this unique process is opening up some completely new application fields.



Particle size measurement CILAS 1064 wet
Measurement range: 0.04 µm - 500.00 µm

Ultrafine Products in Submicron Range

Examples of Products	Feed fineness d_{99} [µm]	Final fineness d_{50} [µm]	Final fineness d_{99} [µm]	Throughput capacity [kg/h]	Size
Aluminum oxide	69.0	0.13	0.35	9.95	s-Jet® 500
Aluminum oxide	72.2	1.33	4.52	250	s-Jet® 1000
Aluminum oxide	178	20.1	82.7	902	s-Jet® 500
Barium titanate	5.55	0.13	0.39	1.32	s-Jet® 25
Boron nitride	3.67	0.32	0.77	5.80	s-Jet® 500
Boron nitride	20.5	0.97	2.78	6.43	s-Jet® 150
Chrome carbide	2.4 % > 1 250 µm	0.34	1.18	2.35	s-Jet® 500
Chrome carbide	2.4 % > 1 250 µm	2.60	6.52	62.6	s-Jet® 500
Iron oxide	4.03 (d_{90})	0.07	0.37	61.2	s-Jet® 500
Iron oxide	28.3	0.47	5.84	24.0	s-Jet® 500
Feldspar	66.7	0.48	1.75	11.2*	s-Jet® 500
Feldspar	66.7	3.53	14.1	434	s-Jet® 500
Glass frits	12.3 % > 1 000 µm	1.54	3.47	10.5	s-Jet® 500
Graphite	130	0.79	2.03	5.93	s-Jet® 500
Graphite	109	4.87	14.1	71.6	s-Jet® 500
Ceramic pigment	18.5	0.13	0.34	10.3*	s-Jet® 500
Ceramic pigment	5.60	0.94	3.09	158*	s-Jet® 500
Ceramic pigment	25 % > 500 µm	1.02	4.32	500*	s-Jet® 1000
Silica	21.9	0.41	4.18	250	s-Jet® 2000
Rice husk ash	103	2.80	7.16	144	s-Jet® 500
Rice husk ash	103	8.77	41.3	535	s-Jet® 500
Silicon carbide	6.3 % > 800 µm	0.24	1.04	7.70	s-Jet® 500
Silicon carbide	6.3 % > 800 µm	9.26	43.2	230	s-Jet® 500
Talcum	87.8	1.29	5.30	18.1	s-Jet® 500
Talcum	22 % > 500 µm	20.9	71.5	870	s-Jet® 500
Titanium dioxide	2.15	0.13	0.34	191*	s-Jet® 500
Tricalcium phosphate	22.8	0.44	1.57	4.00	s-Jet® 500
Tricalcium phosphate	22.8	1.67	7.66	73.0	s-Jet® 500
Wollastonite	17.4	0.30	2.64	8.70	s-Jet® 500
Wollastonite	17.4	2.42	15.5	105	s-Jet® 500
Zeolite	8.33	0.73	2.25	6.90	s-Jet® 500
Zinc oxide	17.3	0.13	0.35	6.10	s-Jet® 500
Zinc oxide	17.3	0.87	4.80	183	s-Jet® 500
Zirconium oxide	28.6	0.15	0.59	10.5*	s-Jet® 500
Zirconium oxide	37.6	2.33	8.53	105	s-Jet® 500

* with dispersing agent

CONSTRUCTION SIZE &

TECHNICAL DATA

NETZSCH offers the steam jet mill of the *s-Jet*® series in various sizes not only as an individual machine, but rather as a complete plant including steam generation which can be adapted to suit the requirements of the customer.

This technology is not only available in the form of production scale machines but also on a laboratory- and small scale. The NETZSCH Steam Jet Mill *s-Jet*® 25 is designed for the production of small amounts, product samples and samples for application tests. The compactly constructed laboratory scale plant includes all required components such as dosing, mill, product separation, control system, fittings and steam generator installed on a skid. The space requirement for the installation of the complete steam grinding plant is a mere 3 m^2 with a maximum necessary height of only 2450 mm.

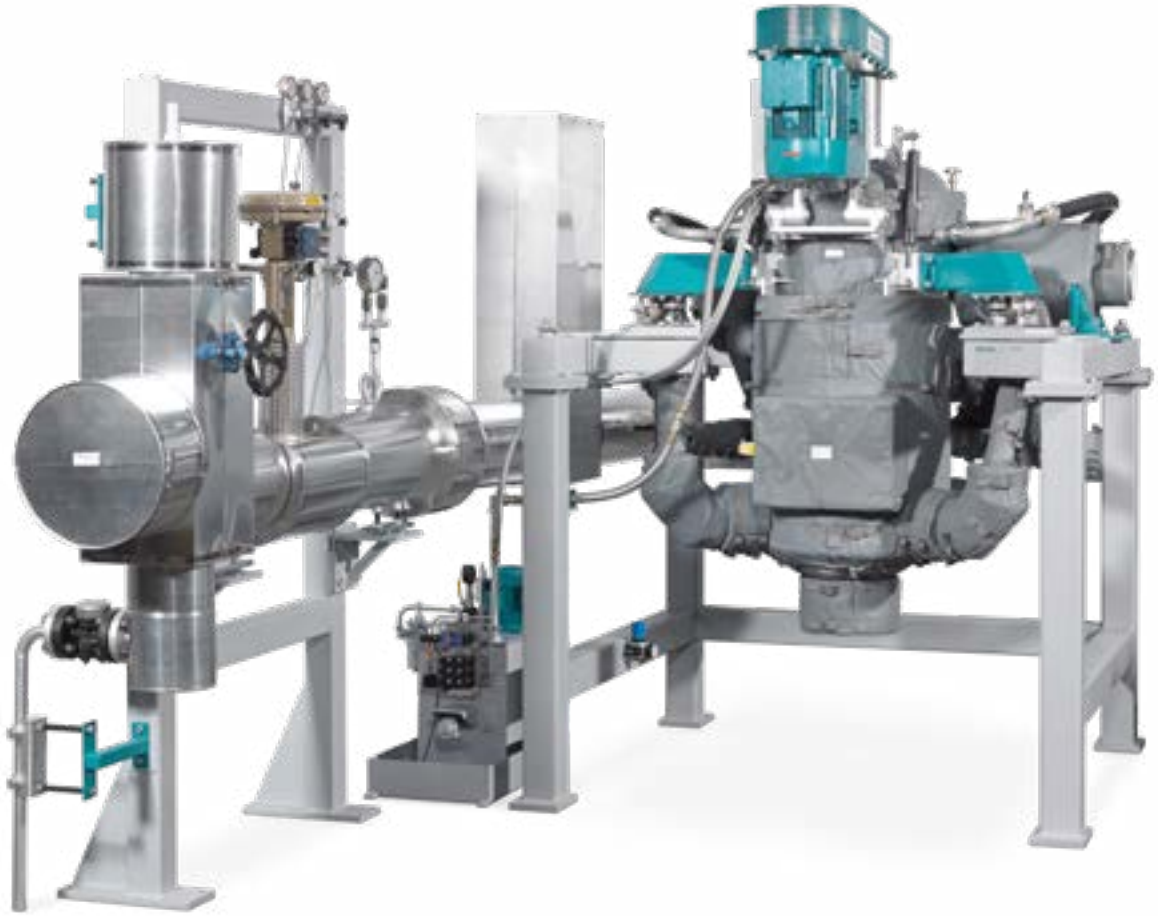
s-Jet® 25 – Focus on your Advantages

- Ergonomic Design
- Easy cleaning
- Product feed via gravimetric dosing and injector system
- Compact system installed on a skid
- Integrated control system for automatic mode of operation, which guarantees a high degree of safety and reproducibility

NETZSCH Steam Jet Mill *s-Jet*® 25

Technical Data	Capacity Factor	Steam Mass Flow [kg/h]*	Steam Pressure [bar]	Temperature [°C]	Throughput Capacity [kg/h]**	Fineness d_{50} [µm]***
s-Jet® 25	-	25	bis 11	300		0.1 - 50
s-Jet® 150	0.35	75 - 150	10 - 100	230 - 360	2 - 150	0.1 - 100
s-Jet® 500	1	250 - 500	10 - 100	230 - 360	6 - 500	0.1 - 100
s-Jet® 1000	2	500 - 1000	10 - 100	230 - 360	12 - 1000	0.1 - 100
s-Jet® 2000	4	1000 - 2000	10 - 100	230 - 360	30 - 2000	0.2 - 120
s-Jet® 3000	6	1500 - 3000	10 - 100	230 - 360	45 - 3000	0.2 - 120
s-Jet® 6000	12	3000 - 6000	10 - 100	230 - 360	100 - 6000	0.3 - 150

* Based on a steam pressure of 11 bar (s-Jet® 25) otherwise 40 bar
** Depending on fineness and product
*** Based on aluminum oxide



TEST CENTER &

TOLL GRINDING

Steam Jet Mill *S-JET*® 150
in NETZSCH Test Center

NETZSCH offers you comprehensive service

Test Center

The NETZSCH application laboratories are equipped with the latest technology and are an important part of our comprehensive service offer. In the NETZSCH application laboratories your products can be processed and their behavior analyzed carefully in order to achieve the very best test results with the highest degree of efficiency. When testing is completed, a detailed report is prepared and sent to your company as well as samples of the final product. You are most welcome to witness the tests in our test center in order to ensure that everything is carried out according to your instructions. NETZSCH would be delighted to welcome you to Hanau!

NETZSCH offers you comprehensive service

Toll-Grinding

For your finest classifying jobs or even challenging grinding applications and the relevant analyses – NETZSCH can always offer you a quick and professional solution. These solutions can assist you in e.g. bridging a capacity bottleneck, introducing new products or outsourcing your own production. With its three toll-grinding locations in Germany - Bobingen, Hanau and Selb - NETZSCH can offer you worldwide-leading, ISO-certified processing technology – "Made in Germany". We combine tradition and expertise to produce future-oriented products of excellent quality and designed with state-of-the-art technology.

Focus on your Advantages

- No capital commitment
- No personal investment
- Flexible and with calculable risk during the market launch phase
- Planning security for your decision processes
- Bridging of capacity bottlenecks

The owner-managed NETZSCH Group is a leading global technology company specializing in mechanical, plant and instrument engineering.

Under the management of Erich NETZSCH B.V. & Co. Holding KG, the company consists of the three business units Analyzing & Testing, Grinding & Dispersing and Pumps & Systems, which are geared towards specific industries and products. A worldwide sales and service network has guaranteed customer proximity and competent service since 1873.

Proven Excellence.

Business Unit Grinding & Dispersing – The World's Leading Grinding Technology

NETZSCH-Feinmahltechnik | Germany
NETZSCH Trockenmahltechnik | Germany
NETZSCH Vakumix | Germany
NETZSCH Lohnmahltechnik | Germany
NETZSCH Mastermix | Great Britain
NETZSCH Broyage | France
NETZSCH España | Spain
NETZSCH Machinery and Instruments | China
NETZSCH India Grinding & Dispersing | India
NETZSCH Tula | Russia
NETZSCH Makine Sanayi ve Ticaret | Turkey
NETZSCH Korea | Korea
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customer portal

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